

7

LPG installations

The Boat Safety Scheme Essential Guide



For more technical information

The requirements in this chapter have been informed by, and may refer to, the following technical references, codes and regulations. If you are building, fitting-out or making substantial changes to a vessel, we strongly recommend you refer to, and take account of, the codes and standards below:

- **BS 669:1997** 'Flexible hoses, end fittings and sockets for gas burning appliances'
- **BS 3212:1991** 'Specification for flexible rubber tubing, rubber hose and rubber hose assemblies for use in LPG vapour phase and LPG/air installations'
- **BS EN 1763-1:2001** 'Rubber and plastics tubing, hoses and assemblies for use with commercial propane, commercial butane and their mixtures in the vapour phase'
- **BS EN ISO 7840:2004** 'Small craft. Fire-resistant fuel hoses'
- **BS EN ISO 10239:2000** 'Small craft. Liquefied petroleum gas (LPG) systems'
- **PD 5482-3:2005** 'Code of practice for domestic butane and propane gas-burning installations – Part 3: Installations in boats, yachts and other vessels'
- **Statutory Instruments 1998 No. 2451** 'The Gas Safety (Installations and Use) Regulations 1998' (www.hmso.gov.uk/si/si1998/19982451.htm#end)
- **Calor Gas: 'LPG (Bottled Gas) for Marine Use'**



BSS Essential Guide

LPG (Liquefied Petroleum Gas) is kept under pressure as a liquid and when released, becomes a highly flammable gas that is much heavier than air. The gas industry also knows it as one of the most searching of gases, that is, it can escape through gaps that would hold water and other gases.

This chapter explains how to minimise the risk of LPG escaping into your boat's interior, where it could quickly build up from the bottom of the boat forming an explosive 'mix' of gas and air. Therefore, we explain in this chapter how you must store LPG, how to arrange the gas supply system and how to protect the gas supply installations from heat and impact damage.

This chapter covers the reasons for shut-off valves and appliance isolation valves to control the LPG supply, and the importance of having the system installed in a way that minimises risk. We strongly recommend that any work on LPG systems be carried out by a suitably competent person. We further recommend reading our leaflet 'Avoiding Fire Afloat – Safe Use of LPG' which has useful advice on staying safe when changing cylinders, what to do if you suspect a gas leak and some checks to help prevent emergencies.



Boats obliged to meet BSS requirements must comply with the following:

- 18** All LPG systems must be designed, installed and maintained in a way that minimises the risks of explosion or of fire starting and spreading.

- 19** All LPG containers and high-pressure components must be secured in a position where escaping gas does not enter the interior of the vessel.

- 20** All LPG systems must be designed, installed and maintained to ensure gas-tight integrity.

- 21** All LPG system connections and flexible hoses must be accessible for inspection.

- 22** All LPG control and shut-off devices, or the means to operate them must be readily accessible.
-
- 23** LPG shut-off valves, or their means of operation, must be marked when not in clear view or when their function is not clear.
-
- 24** All LPG systems must have a suitable means to test that the system is gas-tight.
-

An important preface on the nature of LPG

On boats, the Liquefied Petroleum Gases in common use are, 'commercial butane', and 'commercial propane'. They exist as gases at normal temperatures, but become a liquid under moderate pressure. Propane turns into gas at a lower temperature than butane, so the storage pressure for liquid propane is slightly higher than butane.

One volume of liquid butane or propane produces approximately 250 volumes of gas and thus a leak of liquid is a grave hazard, especially on a boat. Since LPG vapour is denser than air, leaked LPG vapour will fall and flow along cockpit floors, bilges, etc and the vapour may travel some distance. The LPG will build up in low-lying parts of your boat and it may persist for some time.

It only needs concentrations of 2–10% LPG in air to make a flammable mix. In a boat, a flammable mix will explode if ignited. It is also possible for gas/air mixtures from leaks or other causes to be ignited some distance from the point of leakage and the flames travel back to the source before exploding. In extreme cases, if the cylinder is lying on its side; if the cylinder valve is faulty; or if the exposure to the fire is extended, the cylinder may rupture leading to a violent explosion. Alternatively, the point could be reached where the pressure-relief valve releases LPG, causing a significant jet of burning gas.

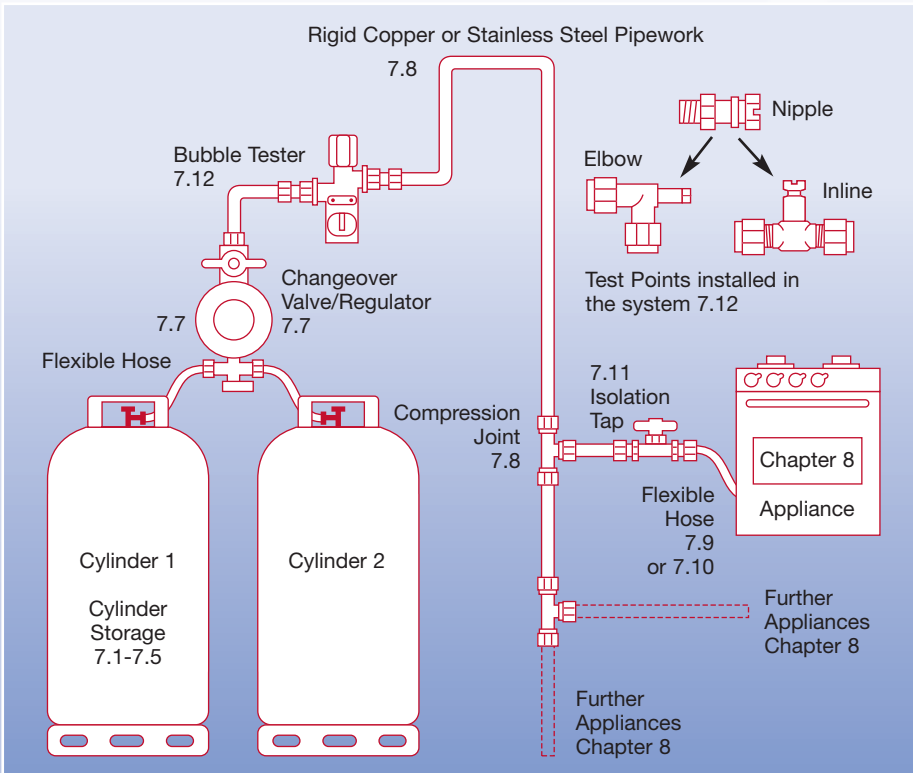
To help prevent incidents, a stenching agent is added to give LPG a strong odour, which most people can smell long before the gas reaches dangerous concentrations.

[Based on information from the LP Gas Association]

LPG installation testing

All LPG installations must meet the gas-tightness testing requirements of PD 5482-3. Meeting these requirements will give an assurance that the installation is gas-tight at the time of the test. However, to minimise the risks of gas leaks into your boat, it is also critical that all maintenance and changes to LPG installations are carried out competently.

At the time of examination, it is very important to ensure that all appliances to be tested are in working order and that your boat has enough gas, water and electrical power on board for testing to take place. If appliances cannot be tested, the examination will be incomplete and, where this relates to a requirement, no certificate can be issued (see Chapter 1).



7.1 Location of LPG cylinders - escaped gas must drain overboard

This section deals with preventing escaped LPG building up inside your boat.

If located in the wrong place or in the wrong way damaged LPG cylinders, their valves, or fittings could cause gas to leak into your boat's interior. As it builds up, there will be a growing risk of it causing a fire or explosion.

7.1.1/R REQUIREMENT

Are all LPG cylinders and containers stored in a position where any leakage will be directed safely overboard?

Check for the presence of any LPG cylinders or containers. If present, check whether their location is in either a cylinder locker or an open location.

If located in a cylinder locker apply the checks at 7.2–7.5.

If located in an open location:

- identify the type of any cockpit storage location;
- check the location for any barriers to leaked LPG flowing overboard;
- check location for any openings into the interior of the vessel, or for any source of ignition, within 1m (39in) distance.

All LPG cylinders or containers, whether full, part full or empty must be stored either in a cylinder locker complying with the requirements of the Checklist Items in sections 7.2–7.5, or in an open location.

Cylinders stored in an open location:

- must be outside of a **non** self-draining cockpit or well deck; **and**,
- must be in a position where any leaked LPG would flow overboard unimpeded; **and**,
- must be where there is no opening into the interior of the vessel, or any source of ignition, within 1m (39 in) distance.

Notes – Cylinder housings may be used in open locations. Cylinder housings are ventilated enclosures intended solely for storage of one or more LPG cylinders, pressure regulators and safety devices and located on the exterior of the craft, where any leakage would flow overboard. [ISO 10239].

The storage arrangements of cylinders, not in cylinder lockers, stored in *self-draining cockpits* should be assessed against Checklist Item 7.2.4.

Sources of ignition include open-flame or spark-inducing equipment. Solenoid LPG system shut-off valves of suitable proprietary manufacture are presumed not to be a source of ignition. Outboard motors within 1m (39 in) of cylinders are **not** to be considered a source of ignition.

Best practice

b

Although it is compliant, we do not recommend storing cylinders and the high- and low-pressure connection and associated equipment on the outside face of the transom, owing to the risk of damage in the event of a collision. Should this arrangement be necessary, we recommend that components be adequately protected from potential collision damage.

Self-contained portable gas appliances, which have the burner screwed direct to the cylinder or container, such as a camping stove or lamp, still have the potential to leak sufficient amounts of LPG into the interior of a boat to create an explosive ‘mix’ even when the cylinder is apparently empty and any appliance valve is closed.

7.1.2/R REQUIREMENT

Are all self-contained portable LPG appliances stored so that any LPG leakage will be directed safely overboard?

Check for the presence of self-contained portable appliances having LPG cylinders or containers attached.

If present, apply the checks at 7.1.1.

All self-contained portable appliances having LPG cylinders or containers attached must be stored in accordance with the requirements of 7.1.1.

Note – this check applies to camping-style appliances but not items such as gas hob lighters.

Best practice

Supervise these appliances closely at all times when in use.

Dispose of empty cylinders or canisters safely and do not discard them in waste bins where leaking LPG would be a hazard.

b

7.2 LPG cylinders in a cylinder locker:

Cylinder lockers have many advantages as a place to stow LPG, but they must meet certain criteria to comply with the navigation authorities' requirements and national and international standards.

LPG is one of 'the most searching gases' and will escape quickly from any weak point.

7.2.1/R REQUIREMENT

Is the cylinder locker LPG-tight up to the level of the top of the cylinder valves or other high-pressure components?

Check the extent of the LPG-tight area of all LPG cylinder lockers.

Check the condition of all cylinder locker and housing bottoms and sides.

Cylinder lockers must be LPG-tight to the level of the top of the cylinder valves, **and** other high-pressure components where these are located higher than the valves.

Within the required LPG-tight area, the bottom, sides, and seams of every cylinder locker must be free of holes, cracks, damaged welds, significant corrosion, or other damage.

The above requirements also apply where any part of cylinder housing forms a part of the craft's hull or superstructure.

Note – The LPG-tightness of side-opening cylinder locker doors compliant with ISO 10239 is covered at 7.2.3.

Best practice

Lockers that open from the top or from the outside of the boat are easier to make and keep LPG-tight.

b

7.2.2/R REQUIREMENT

Are the sealing arrangements on pipework exiting the cylinder locker of the correct type to ensure LPG-tightness and in good condition?

Check the position, type and condition of sealing arrangements on pipework exiting cylinder lockers and housings.

Pipework must exit LPG cylinder lockers through either a bulkhead fitting, or cable gland fitting, or be above the LPG-tight level.

The sealing arrangements must be free of signs of damage and deterioration.

The above requirements also apply where any part of cylinder housing forms a part of the craft's hull or superstructure and where the LPG pipe exits the housing into the interior of the vessel.

Note – In the event the pipework exits the locker below the LPG-tight level through a conduit, it is acceptable that the pipework is protected by the effective use of sealant within the conduit.

Side-opening lockers can bring their own difficulties with ensuring an effective seal to the door or preventing gas from flowing into your boat's interior.

7.2.3/R REQUIREMENT

Are arrangements on side-opening cylinder lockers compliant with ISO 10239?

Check that the location of any side-opening locker door is outside of the interior of the vessel.

Visually check the condition of the door seals.

If the seals appear free of gaps, damage and deterioration, apply the check at 7.2.4.

If the seals appear free of gaps, damage and deterioration; and the arrangements do **not** satisfy the check at 7.2.4, call the BSS Office for further advice concerning conducting a smoke-pellet test.

Side-opening lockers must not be able to be opened from the interior of the vessel.

The seals of any side-opening cylinder locker door must be LPG-tight; **and**, must be free of signs of gaps in the contact with the locker body; **and**, must be free of damage or deterioration.

Door seals with no signs of gaps or damage must satisfy check 7.2.4 or pass the smoke-pellet test.

Note – If the arrangements on your boat do not meet the requirements set out in 7.2.3, the boat can still be compliant if it meets Checklist Item 7.2.4.

7.2.4/R REQUIREMENT

Do the arrangements in a self-draining cockpit prevent LPG entering the interior of the vessel?

Verify the cockpit is self-draining.

Verify the presence of LPG cylinders not in a cylinder locker.

If present, verify whether the self-draining cockpit arrangements prevent LPG entering the interior of the vessel by checking:

- the height of cockpit drain outlets in relation to the normal laden waterline; **and**,
- the height to which cockpit is LPG-tight; **and**,
- the condition of any hatches or openings, and associated seals, gaskets, below the height of the cylinders, regulators and associated equipment.

If the effectiveness of side-opening cylinder locker door seals cannot be verified, or if cylinders are stored in cylinder housings, then the arrangements of a self-draining cockpit must be as follows:

- the height of cockpit drain outlet(s) must be above normal laden waterline; **and**,
- the cockpit must be LPG-tight to the interior of the vessel at least to a height equal to that of the height of the top of the LPG cylinder valves and other high-pressure components where these are located higher; **and**,
- hatches or openings, and associated seals, gaskets, below the height of the LPG cylinder valves and other high-pressure components where these are located higher must be free of signs of damage or deterioration.

Notes – This Checklist Item is relevant to cylinders in self-draining cockpits where, either the side-opening cylinder locker door seal fails the test at 7.2.3, or cylinders are not stored in any enclosure or, cylinders are stored in a cylinder housing.

In the event that the arrangements comply with 7.2.3, the Checklist Item at 7.2.4 is not applicable.

7.3 Cylinder locker drains

This section considers the importance of having an effective drain for escaped gases in any cylinder locker.

If a blocked drain causes leaked gas to build up in your locker, there is a risk of it being ignited. Even comparatively small amounts of LPG can cause a serious explosion.

7.3.1/R REQUIREMENT

Is there a drain in the cylinder locker and is the drain outlet above the waterline?

Identify the presence of a drain in each cylinder locker.

Identify the cylinder locker drain outlet on the outside of the hull and verify that it is above the normal laden waterline.

All cylinder lockers must be fitted with a drain.

Cylinder locker drain outlets must be above the normal laden waterline.

7.3.2/R REQUIREMENT

Is the drain opening at or close to the bottom of the cylinder locker or is any volume beneath the drain-opening minimised by the use of suitable material?

Check the location of the cylinder locker drain-openings.

If the drain opening is above the bottom of the locker check that any area below the drain opening that could retain leaked LPG is filled with LPG-resistant material.

Cylinder locker drain-openings must be located at the bottom of the locker or at the lowest point of the side.

Any area in the cylinder locker below the drain that could retain leaked LPG must be filled with LPG-resistant material.

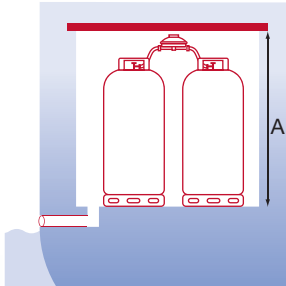
Note – Drain openings on the side of cylinder lockers not greater than 25mm (1 in) above the bottom of the locker may be considered as at the lowest point of the side.

7.3.3/R REQUIREMENT

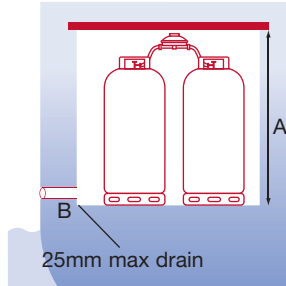
Is the cylinder locker clear of any items that could block the drain?

Check cylinder lockers for any items that could block the drain.

Cylinder lockers must be clear of any item that could block the drain.

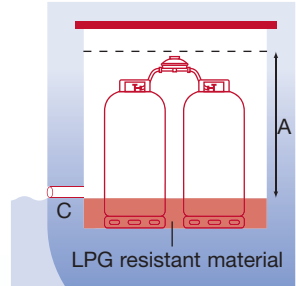


Bottom drain



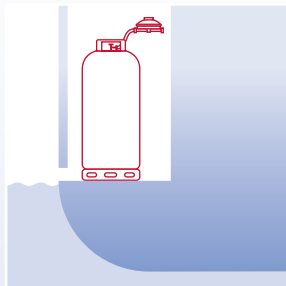
Side

25mm max drain

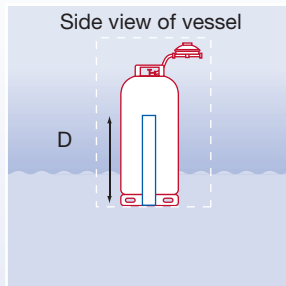


Bottom drain equivalent

LPG resistant material



Direct Opening



Side opening or series of holes

Side view of vessel

7.2 LPG-tightness and 7.3 cylinder locker drains

A. 7.2.1 Is it LPG-tight up to the top of the cylinder valves?

B. Side opening drain must comply with 7.3.2

C. Side opening drain below which is filled LPG-resistant material 7.3.2

D. Slit opening must comply with 7.3.6

7.3.4/R REQUIREMENT

Does the drain line fall continuously from the cylinder locker to the external connection and are both ends clear of blockage?

Check the completeness and fall of the drain line to the external connection where it can be seen.

Check the drain openings in the cylinder locker and at the external connection for obstruction.

Cylinder locker drain-lines must be continuous and must fall continuously to the external connection so as not to retain leaked LPG.

Drain openings in the cylinder locker and at the external connection must not be blocked.

Note – A bucket of water can be used to aid verification of Checklist Items 7.3.4–7.3.6. At examination, the examiner may ask your permission to use water to test the drain, if appropriate.

If the drain line material or connections deteriorate, this could cause LPG to enter the boat and cause an explosion or fire.

7.3.5/R REQUIREMENT

Is the drain line material, including the connections, in good condition?

Check condition of cylinder locker drain-line material that can be seen.

Check condition of all connections that can be seen.

Where connections can be reached, pull using light manual force to check security of all hose connections.

The material of drain lines must be in good condition and all connections must be complete and free of signs of damage or deterioration.

Drain hoses must be free of any signs of damage and deterioration, including 'soft' spots or kinking of the walls.

Drain hose connections made with hose clips or clamps must:

- be suitably sized, that is, not so oversized that the band forms an elliptical shape or so undersized that no tightness is achieved; **and**,
- be appropriately tight, that is, not so loose that the connection can be pulled forward or back under light manual force nor so tight that the hose is excessively pinched; **and**,
- show no signs of damage or deterioration at the clip or clamp; **and**,
- show no signs of damage or deterioration at the hose.

Best practice

We recommend you to fit, whenever possible, drain hose that complies with a recognised standard such as ISO 7840 for fire resistance or BS 3212 for LPG.

b

As the amount of LPG contained in the locker rises, so does the need for effective drainage.

7.3.6/R REQUIREMENT

Does the drain line, or the drain opening, have a minimum appropriate internal diameter or equivalent area?

Measure the internal diameter of each cylinder locker drain opening. Check the drain line that can be seen for no obvious reductions.

Cylinder locker drains must have a minimum internal diameter of 12mm (½ in) or increased pro-rata up to 19mm (¾ in).

Total cylinder capacity	Internal diameter of drain opening or equivalent area	
1-18kg	12mm (½ in)	113mm ²
19-29kg	14mm (9/16 in)	154mm ²
30-37kg	17mm (5/8 in)	227mm ²
38kg or greater	19mm (¾ in)	283mm ²

Note – Equivalent areas of differently shaped drain openings are acceptable.
 Total capacity must be calculated from the sum of the capacity of all cylinders housed in the same locker.
 If the locker has two or more drains, their combined area of openings should be taken account of in assessing compliance.

Best practice
 We recommend all cylinder locker drains are not less than 19mm (¾ in) internal diameter or equivalent area.



7.4 Protecting LPG cylinders and components against damage

LPG cylinders and components can easily be damaged, both by day-to-day activities and by incidents like fire. Therefore, cylinder storage arrangements are important matters in minimising risk.

The preface on the nature of LPG highlights the potential dangers if cylinders are not kept upright. In general, LPG cylinders are designed to be stored and operated in an upright position with their cylinder valve uppermost.

If your cylinders move about they may damage their associated supply line, valves or regulators, causing leaks. Obviously the same risks apply if lockers aren't secure.

7.4.1/R REQUIREMENT

Are all cylinders secured and stored upright with the valve at the top?

Determine by moving the cylinders carefully the extent of any movement.

Check that all cylinders are secured to prevent potential damage to regulators or pipework.

Check the completeness and condition of support structures and fixings on transom-mounted LPG cylinder arrangements.

Check all cylinders are secured in the upright position with the valve uppermost.

The extent of any LPG cylinder movement must not cause any pulling of pipework or hose connections.

Cylinders must be secured so that the possibility of cylinders damaging low-pressure regulators, pipework or other LPG system components is minimised.

The support structures and fixings on transom-mounted LPG cylinder arrangements must be complete and free of signs of damage or deterioration.

Cylinders must be secured in the upright position with the valve uppermost.

7.4.2/R REQUIREMENT

Is the cylinder locker secure?

Apply light manual force to check that cylinder lockers are secure.

Cylinder lockers must be secured against unintended movement.

If you drop heavy objects such as mooring pins or windlasses on a cylinder valve, regulator or other components a leak could be the result.

7.4.3/R REQUIREMENT

Are LPG cylinders in a locker protected against falling objects?

Check for the presence of a lid or cover on all top-opening cylinder lockers.

If not present, check that the cylinders, regulators and associated equipment are otherwise protected.

Top-opening LPG cylinder lockers must either have a lid or cover. If not, cylinders, and other LPG system components must be otherwise protected against falling objects.

Owners using gas lockers casually to store loose objects or for additional purposes e.g. storing batteries run the risk of causing sparks, and/or blocking the locker drain (see Checklist Item 7.3.3).

7.4.4/R REQUIREMENT

Is the cylinder locker clear of any items that could damage the LPG equipment or ignite leaked LPG?

Check the contents of all cylinder lockers.

Cylinder lockers must not contain loose sharp or heavy items such as anchors or mooring pins that could damage the cylinders or other LPG system components.

Cylinder lockers must not contain any item that could ignite leaked LPG.

Note – sources of ignition include open-flame or spark-inducing equipment. Solenoid LPG system shut-off valves of suitable proprietary manufacture are **not** presumed to be a source of ignition.

LPG cylinders overheating in a fire will place people and property in the vicinity of the boat at extreme risk.

7.4.5/R REQUIREMENT

Is the cylinder locker constructed of material of the required thickness?

Determine the construction material of the cylinder lockers and estimate the thickness of the cylinder lockers.

Cylinder lockers must be constructed of materials that are either

- the same material and thickness of the surrounding hull structure; or,
- metal of minimum thickness of approximately 1mm; or,
- FRP of minimum thickness of approximately 5mm (¼ in) thickness.

Note – a combination of wooden cylinder-lockers lined with FRP of a lesser thickness than 5mm (¼ in) may be estimated as equivalent.

7.5 Cylinder locker opening

If cylinder lockers are in high-risk areas and they leak near sources of ignition, this could potentially cause a fire or explosion.

7.5.1/R REQUIREMENT

Are all openings to cylinder lockers outside of any engine, battery, or electrical equipment space?

Check the location of any opening of any cylinder locker.

Cylinder lockers must not open into engine, battery, or electrical equipment spaces.

Information

When choosing a solenoid-controlled shut-off valve, seek the supplier's assurance as to its suitability for use with LPG.



7.6 LPG system shut-off valves

In the event of a gas leak or fire breaking out, it is essential that the LPG supply can be quickly and easily shut off.

7.6.1/R REQUIREMENT

Are all LPG system shut-off valves, or their means of operation, in a readily accessible position?

Identify all valves used for the LPG system shut-off facility and check the accessibility of valves or their means of operation.

LPG system shut-off valves, or their means of operation, must be installed in a readily accessible position.

Notes – LPG system shut-off valves may be cylinder valves.

Systems with clip-on regulators do not require an additional system shut-off valve.

Best practice

Have your readily accessible shut-off valve, outside the accommodation space and as close to the LPG cylinders as possible.

b

7.6.2/R REQUIREMENT

Are the locations of all LPG system shut-off valves, or their means of operation, in open view or their locations clearly marked?

Identify the locations of the valves used for the LPG system shut-off facility. Where LPG system shut-off valve(s), or the means to operate them, are not in open view with all removable lids, deck boards, curtains, doors, etc in place, check for the presence of marking in open view indicating the location.

LPG system shut-off valves, or the means to operate them, must:

- be in open view with all removable lids, deck boards, curtains, doors, etc in place; or,
- have their locations clearly marked in open view.

7.7 High-pressure LPG system components

Location

All LPG fittings and components between the cylinder and the input side of the gas regulator (which is there to reduce and control the output pressure of the bottled gas to a pressure suitable for the appliances) are classed as the 'high-pressure' side of the LPG system.

Damage here could cause a very significant amount of LPG to escape rapidly before the cylinder shut-off valve can be closed. Protection against an influx of gas into the boat interior is therefore crucial.

7.7.1/R REQUIREMENT

Are all high-pressure LPG system components either inside a cylinder locker or in an open location?

Check the location of all high-pressure LPG system components.
Apply the checks at 7.1.1.

All high-pressure components must be installed in accordance with the requirements of Checklist Item 7.1.1.

Best practice

When working efficiently, a non-return valve will prevent a hazard when one cylinder is disconnected. However, early failure of these non-return valves has been reported so we recommend that they are checked regularly and that you renew a valve on any sign of failure.

b

Where two or more cylinders are connected on the high-pressure side e.g. via a wall block, manual or automatic changeover device, there is a risk of LPG escaping at high-pressure when one cylinder is disconnected.

7.7.2/R REQUIREMENT

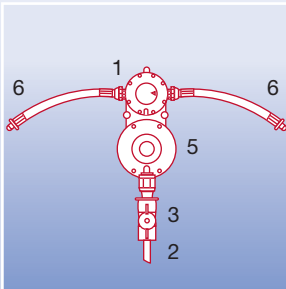
Where two or more cylinders are connected on the high-pressure side, does each connection have a non-return valve fitted?

Identify the presence of cylinders connected on the high-pressure side. If present, check for a non-return valve fitted in each high-pressure connection.

Two or more cylinders connected on the high-pressure side must be protected by a non-return valve fitted in each connection.

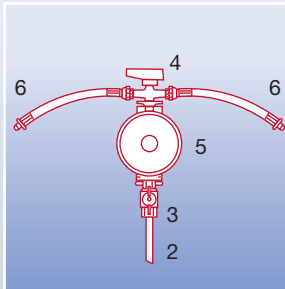
Note – It may not always be obvious whether a non-return valve is fitted. Most modern wall blocks and high-pressure pigtails incorporate them. If you have any doubts, please ask a suitably competent person to advise you.

Automatic Changeover Device



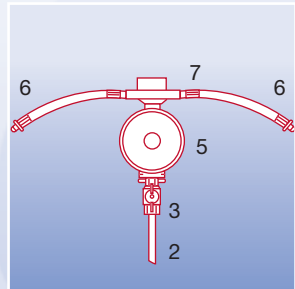
- 1 Automatic Valve
- 2 Low-pressure Gas Supply to Appliances
- 3 Main Shut-off Valve

Manual Changeover Device



- 4 Manually Operated Valve
- 5 Gas Regulator

Wall Block



- 6 High-pressure Pigtails (Hose) to Cylinders
- 7 No Change-over Device

Best practice

Regulators have a finite life and it is generally recommended that they are replaced at least at 10-year intervals.

b

If a high-pressure LPG hose ruptures or becomes disconnected, your boat could be flooded with LPG regardless of its location.

7.7.3/R REQUIREMENT

Are all hoses on the high-pressure side of pre-assembled lengths not exceeding 1m (39 in) and to the correct specification?

Identify the presence of hose on the high-pressure side.

Check the type of hose end fittings.

Measure the length of hose.

Check the hose markings.

All LPG hoses on the high-pressure side:

- must consist of pre-assembled lengths of hose of proprietary manufacture; **and**,
- must not exceed 1m (39 in) in length; **and**,
- must be marked to BS 3212 type 2 or equivalent.

Note – Hoses marked to BS EN 1763 class 3 or 4 are acceptable.

Deterioration or damage to high-pressure components poses a high risk.

7.7.4/R REQUIREMENT

Are all high-pressure LPG system components secure and in good condition?

Check the condition of all regulators and associated high-pressure equipment and hoses and hose connections.

Check fixings for signs of damage or deterioration or missing components.

All high-pressure components, including regulators and associated equipment, hoses and hose connections, must be secure and free from signs of damage or deterioration.

Hose must be free of leaks, flaws, brittleness, cracking, abrasion, kinking, 'soft' spots, or joins.

Fixings must be free of signs of damage or deterioration or missing components.

In the same way, components can be damaged too easily, resulting in gas escape, when cylinders are being changed. It is also important to protect any vent holes in the regulator from water, dust and other debris.

7.7.5/R REQUIREMENT

Are regulators mounted directly on the cylinder(s) or located to prevent damage, including blocking of vent holes?

Check the location of regulators not mounted directly on cylinders.

Check that the vent holes of high-pressure stage components are protected from the ingress of debris or water.

Regulators not mounted directly on cylinders must be located in a position where they are not exposed to possible damage when changing cylinders.

The vent holes of high-pressure stage components must be protected from the ingress of debris or water.

Your LPG appliances operate within a certain pressure range. Above this level, the flame on an appliance may roar and lift off, which could ignite nearby fuel or vapour.

Below this range, an appliance burner may go out, allowing gas to leak into your boat.

7.7.6/R REQUIREMENT

Is the installation free of manually-adjustable regulators?

Check for the presence of any manually-adjustable regulators.

LPG regulators must not be of the manually-adjustable type.

Notes – Manually-adjustable regulators are acceptable for steam boiler or blowlamp engine-start LPG supply systems.

Regulators able to be adjusted upon removal of a ‘tools-to-remove’ dust cap are acceptable.

7.8 LPG metal pipework and connections

‘Pipework’ always refers to rigid supply lines; the section on flexible hose follows at 7.9. Although you will not be required to expose all the pipework for the BSS examination, it is important that all parts of the gas system installation pipework on your boat can be accessed for routine checking, service and replacement. Such routine inspection of the parts of the LPG system that are not readily visible is crucial, as damage or deterioration hidden from everyday view is by its nature a serious risk.

Hence, there are parts of the system that the BSS examiner will have to examine before he or she can issue a certificate. We recommend you plan for a successful examination, by reading this section carefully and making sure that all the required components can be examined.

Best practice

We recommend that pipework should be suitable for use with LPG in a marine environment.

To avoid vibration damage and early deterioration, we recommend that the fixings are not spaced more than 500mm (20 in) apart.

b

Movement and vibration can cause pipes to fracture and connections to loosen. If this happens to your system, the risk of gas escaping and building up in the interior of your craft is great.

7.8.1/R REQUIREMENT

Is the LPG pipework made of a suitable material, adequately secured and free from damage?

Visually check type of material for all LPG pipework that can be seen.
Apply light manual force to check security of LPG pipes that can be reached.

Check condition of all LPG pipes that can be seen or reached.

LPG pipework must be made of either seamless copper tube, or stainless steel tube, or copper nickel alloy.

LPG pipes must not move under light manual force.

LPG pipes must be free of kinks, restrictions, abrasion damage or other deterioration.

Notes – A little movement at the final connection to an appliance is acceptable.

Adhesive directly applied to the pipe is not acceptable as a fixing method.

Pay particular attention to the potential for abrasion damage on pipes passing through bulkheads.

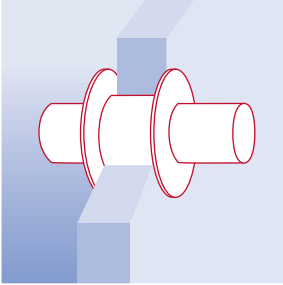
Pipework passing through bulkheads, especially metallic ones, are at high risk of damage from abrasion. (See illustration Pg 25)

7.8.2/R REQUIREMENT

Is the LPG pipe protected where it passes through metal bulkheads or decks?

Check the protection of LPG pipes passing through metallic bulkheads or decks that can be seen or reached.

LPG pipes passing through metallic bulkheads or decks must be protected by the use of sleeves, grommets, or bulkhead fittings.



The pipe is passing through a bulkhead and the grommet supports it and protects against rubbing damage.
7.8.2

Joints are always higher-risk areas for potential leaks. If they are inaccessible, you cannot check their soundness and appropriateness. Inappropriate joints, can cause a gas escape, especially under conditions of stress.

7.8.3/R REQUIREMENT

Are all LPG pipe joints accessible for inspection and of the correct type?

Check the accessibility and type of all pipe joints.

All LPG pipe joints must be accessible for inspection.

All LPG pipe joints must be compression fittings on copper pipework or compression or screwed fittings on copper alloy or stainless steel pipework.

Notes – Where joints are inaccessible for inspection and their type is ‘not verifiable’, they are considered as non-compliant until their type is verified as acceptable.

Inspection panels to allow access to joints are considered compliant.

Best practice

Pipes that enter joints at abnormal angles can make a weak connection that may leak over time. It is best to have joints at a point where stress is minimal.

b

Stress and weakness in pipes has a number of sources, but all can be managed.

7.8.4/R REQUIREMENT

Are all LPG pipe joints secure, in good condition and competently made?

Measure the distance fixing clips are attached from all joint connections.

Apply light manual force to check security of each joint.

Check condition and completeness of fixings and joints.

Check all joints for the presence of unnecessary components.

All LPG pipe joints:

- must have fixing clips attached no more than 150mm (6 in) from each joint connection and must not move under light manual force; **and**,
- must have fixings that are free of signs of damage or deterioration or missing components; **and**,
- must be free of any signs of missing components, cracks or other signs of damage or deterioration; **and**,
- must be made with a minimum number of individual components.

Notes – Adhesive directly applied to the pipe joints is not acceptable as a fixing method.

Fixings are required on **all** sides of joints.

Where joints are inaccessible for inspection and their condition is 'not verifiable', they are considered as non-compliant until their condition is verified as acceptable.

Joints, such as reducing joints, are not expected to be made up of more than two individual components.

It is very easy for disused spurs or runs to be a source of gas escapes through poor capping, poor maintenance, damage or casual usage of taps, for example.

7.8.5/R REQUIREMENT

Are all unused appliance spurs properly capped or plugged?

Identify any unused appliance spurs and check they are closed with a 'tools-to-remove' proprietary plug or cap.

All unused appliance spurs must be closed with a 'tools-to-remove' proprietary plug or cap.

A gas escape into a petrol engine compartment or electrical equipment space, with the potential for a mix of fuels combining with multiple sources of ignition, which would create a serious risk of fire or explosion.

7.8.6/R REQUIREMENT

Are all LPG pipes running through petrol engine spaces or electrical equipment spaces jointless and in a gas-proof conduit?

Check for any LPG pipes running through petrol engine or electrical equipment spaces.

LPG pipes run through petrol engine spaces or electrical equipment spaces:

- must be jointless **and** in gas-proof conduit; which also,
- must be jointless with its ends outside the affected space; **and**,
- the conduit must be complete and free of signs of damage or deterioration.

Best practice

We recommend that unused spurs be plugged or capped at the 'T' joint on the supply line.

We recommend following industry best practice and keep the pipework as high as possible to help protect it from mechanical damage and allow you to smell a leak more easily if one occurs.

This advice also applies to the potential for water damage in the bilges, wherever possible, try to keep the pipework in the dry.

b

The effect of heat on pipework can cause it to expand and contract, which can lead to hardening of the pipework or loosening of its joints, which in turn could allow gas to escape.

7.8.7/R REQUIREMENT

Is the LPG pipe at least 75mm (3 in) from exhaust system and flue components?

Measure the distance that any LPG pipes are from exhaust system and flue components.

LPG pipes must be at least 75mm (3 in) from exhaust system and flue components.

Best practice

We recommend having 100mm (4 in) as the minimum gap between LPG pipe and exhaust or flue components.

b

7.9 LPG hoses and hose connections

As all flexible gas hose has a limited life, it is important to minimise the amount that is used on your boat. Please try and use the minimum practicable length.

Flexible hose, unsuitable for use with LPG will rapidly deteriorate and fail.

7.9.1/R REQUIREMENT

Are all LPG hoses on the low-pressure side accessible for inspection, of the correct material and in good condition?

Check the accessibility of all LPG hoses.

Check the markings of all LPG hoses.

Check the condition of hoses.

All LPG hoses must be accessible for inspection along their entire length.

All LPG hoses must be marked to BS 3212 type 2 or equivalent.

Hoses must be free of leaks, flaws, brittleness, cracking, abrasion, kinking, 'soft' spots or joins.

Note – hoses marked to BS EN 1763 class 2, 3 or 4 are acceptable.

At the time of inspection, hoses that are not accessible along their entire length are 'not verifiable', and will be considered as non-compliant until their general condition has been verified as meeting the requirement.

Pre-made flexible hose connections conforming to BS 669 may be used for cooker connections. Such hose connections usually have a red stripe running along the length of the hose and must terminate with self-closing bayonet connections. The portable appliance connection checks at 7.10 also apply.

Best practice

To prevent damage from abrasion and deterioration, we strongly recommend you follow industry best practice and ensure that any flexible hoses are installed without stress or tight radius turns on your craft.

b

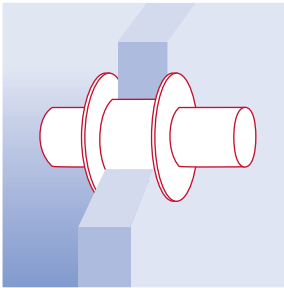
Abrasion can quickly weaken the flexible hose to a point where it will leak.

7.9.2/R REQUIREMENT

Is all LPG hose protected against damage where it passes through bulkheads, decks or partitions?

Check the protection for LPG hoses passing through bulkheads, decks or partitions.

LPG hose passing through bulkheads, decks or partitions must be protected by the use of sleeves or grommets.



The hose is passing through a bulkhead and the grommet supports it and protects against rubbing damage.
7.9.2

Extreme heat will very quickly weaken LPG hose and long-term exposure to moderate heat will cause weaknesses in the hose walls.

7.9.3/R REQUIREMENT

Is all LPG hose at least 75mm (3 in) from exhaust system and flue components?

Measure the distance that any LPG hoses are from exhaust system and flue components.

LPG hoses must be at least 75mm (3 in) from exhaust system and flue components.

b**Best practice**

We recommend checking that any LPG hose is kept away from hot surfaces where temperatures may reach 50°C (122°F) or above such as

- Gas fridge flues
- Stoves
- Cookers
- Diesel heater exhausts.

Flexible hose can be used to connect the installation pipework to a gimbaled cooking appliance to allow for the movement. Other appliances such as your cooker or refrigerator can be connected by hose for ease of installation, cleaning or servicing.

Unnecessarily long lengths of flexible hose will introduce unreasonable risks.

7.9.4/R REQUIREMENT

Are all LPG hoses connecting appliances to supply pipework a maximum of 1m (39 in) in length?

Measure the length of any LPG hoses used to connect appliances to supply pipework.

LPG hoses used to connect appliances to supply pipework must not exceed 1m (39 in) in length.

The nature of hose, its deterioration with age, its vulnerability to heat and to damage, means that the risks associated with its use and the need for its regular checking and maintenance are all important.

7.9.5/R REQUIREMENT

Are all LPG hose connections accessible for inspection, of the correct type, secure and in good condition?

Check the accessibility of all hose connections.

Check types of all LPG hose connections.

Check the type, condition, and completeness of all hose connections.

Pull using light manual force to check security of all hose connections.

All LPG hose connections:

- must be accessible for inspection; **and**,
- must be part of pre-assembled lengths of hose of proprietary manufacture (high- and low-pressure applications); or use suitable nozzles secured by crimped or worm-drive clips (low-pressure applications only); **and**,
- must not be made using hose clamps fixed by spring tension; **and**,
- must be free of any missing components, cracks, burrs or rough edges or signs of other damage or deterioration; **and**,
- must not be so narrow as to cut into the hose; **and**,
- where made with crimped or worm-drive clamps, the clamps must be suitably sized, that is, not so oversized that the band forms an elliptical shape, or so undersized that inadequate compression is achieved; **and**,
- be appropriately tight, that is, not so loose that the connection can be pulled forward or back under light manual force nor so tight that the hose is excessively pinched.

Notes – Hose connections that are not accessible for inspection are ‘not verifiable’, and will be considered as non-compliant until their type, security and condition have been verified as meeting the requirement.

Inspection panels to allow access to joints are considered compliant.

Best practice

We recommend the use of hose clamps of approximately 8mm ($\frac{5}{16}$ in) width.

b

'All-hose' supply system

We cannot recommend using 'all-hose' systems since hose is known to permeate gas through its walls and it is not highly resistant to mechanical damage. LPG hose has minimal fire resistance. It deteriorates with age, with exposure to sunlight and exposure to the elements. If you are considering an all-hose system for new purchase or replacement, you are cautioned to consider these issues very carefully.

BS EN ISO 10239:2000 does recognise continuous 'all-hose' LPG supply-lines, however the UK National Annex also makes the following points: 'In line with the previous requirements in BS 5482-3, it is recommended that any application of LPG hose should be of minimum practical length. The installation should allow for regular inspection, at least annually, and for replacement if any deterioration is found.'

The risk of deterioration or damage to an all-hose system is much greater compared to that of pipework systems.

7.9.6/R REQUIREMENT

Do 'all-hose' systems comply fully with ISO 10239?

Check that 'all-hose' systems are fully compliant with ISO 10239.

'All hose' systems must fully comply with ISO 10239 as follows:

- each length of hose must be routed from within the cylinder locker or housing directly to the individual appliance or appliance isolation valve; **and**,
- hoses must have permanently attached end fittings, such as swaged sleeve or sleeve and threaded insert; **and**,
- hoses must not be routed through an engine compartment; **and**,
- hoses must be accessible for inspection over their entire length and connections must be readily accessible; **and**,
- hose connections must be stress free, i.e. not subjected to tension or kinking under any conditions of use; **and**,
- hoses must be supported at least at 1m (39 in) intervals.

Notes – ‘All-hose’ systems are those not using rigid pipework and will generally be found on imported boats, CE marked to the RCD, where the builder has chosen to apply ISO 10239.

For multi-appliance systems to ISO 10239, we anticipate a manifold arrangement within the cylinder locker or housing.

All of the hose and hose connection **condition** checks at 7.9.1 and 7.9.5 also apply.

Single cooking appliances connected by hose of no more than 1m (39in) in length directly to a regulator are acceptable and need not be assessed against this check.

7.10 Portable appliance connections

A portable appliance for the purposes of the Scheme is one designed to be portable and connected to the LPG supply system by flexible hose.

As its name suggests, a portable appliance will be connected and disconnected regularly. This introduces extra hazards in terms of the isolation of the appliance, the reliability of the supply line and the potential for weak points. These matters are considered in this section.

7.10.1/R REQUIREMENT

Are all portable appliance connections provided with an isolation valve?

Identify all portable appliance connections and check for the presence of an isolation valve.

Apply the checks at 7.11.2 and 7.11.3.

All portable appliance connections must be fitted with an isolation valve.

Where appliances have been permanently removed or temporarily removed for servicing, there is increasing potential for gas leaks.

7.10.2/R REQUIREMENT

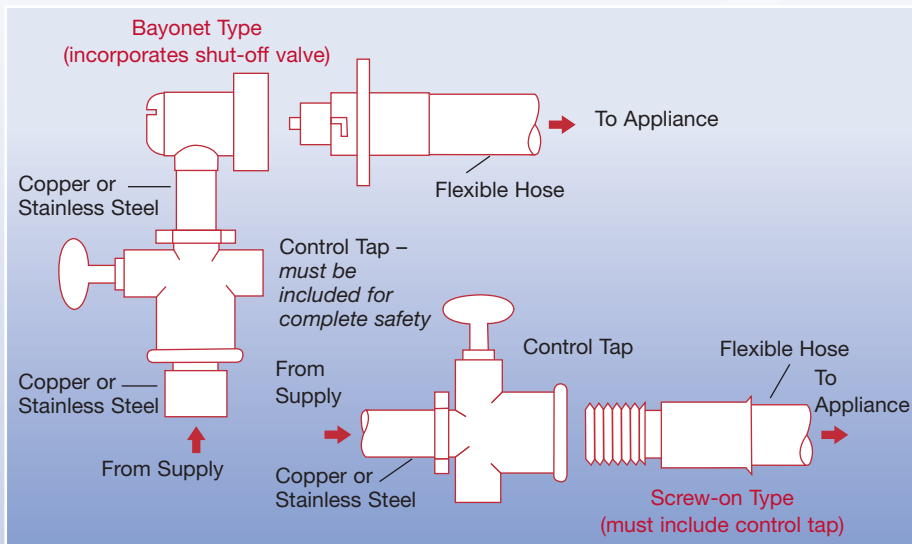
Are portable appliance hoses connected with bayonet, plug or screwed fittings, complete and in good condition?

Identify the type of appliance hose connection to the isolation valve.

Check all connections for completeness and condition.

All hose connections to the isolation valves of portable appliances must be made with a bayonet, plug-in or screwed fitting.

All bayonet, plug-in or screwed fittings must not be missing any components and must be free of corrosion, signs of damage or deterioration.



Unused threaded connections must be backed up with a secondary means of shutting off the gas supply.

7.10.3/R REQUIREMENT

Are all unused screwed portable appliance connection points properly capped or plugged?

Identify any unused screwed appliance connection points and determine how they are plugged or capped.

All unused screwed appliance connection points must be closed with a 'tools-to-remove' proprietary plug or cap.

7.11 Appliance isolation valves

These valves allow the individual appliance, to be isolated or made safe, as well as providing a safe shut-off to disconnect for replacement or maintenance purposes.

Flexible hose fails over time so you will need a feature that allows the connection to be isolated safely from the main supply system if it cracks, leaks or otherwise needs replacing.

7.11.1/R REQUIREMENT

Can all appliance supply hoses be isolated through individual shut-off valves?

Identify every appliance connected by a flexible hose and confirm the presence of an individual shut-off valve at the connection to the supply line.

Appliances connected by a flexible hose must be provided with an individual shut-off valve at the connection to the supply line.

Notes – For an installation with a single appliance connected by a hose, the cylinder valve may be classed as the appliance isolation valve.

Ease of access takes precedence over the requirement for the valve to be located at the connection to the supply line.

Hob/oven arrangements may be deemed one appliance for the purposes of this check.

The nature of LPG means that the use of unsuitable valves can allow gas to leak.

7.11.2/R REQUIREMENT

Are appliance isolation valves of the correct type?

Identify the type of all appliance isolation valves.

Any tapered plug-type valves used as isolation valves must be spring loaded.

Needle-type valves used as isolation valves are not permitted.

Appliance isolation valves at floor level must either be of the drop-fan or loose-key type or of a type that cannot be operated inadvertently.

Note – If the spring on a spring-loaded tapered plug valve is found not to be free to operate without interference because of its close fitting against the surface behind it, then the valve is not to be considered as being spring-loaded.

Not closing the right valve to isolate an appliance can lead to a gas escape.

It may also be important for the isolation valves to be quickly identified, and closed by anyone coming onto the boat, but the main shut-off valve is the key one to make the whole system safe.

7.11.3/R REQUIREMENT

Are appliance isolation valves, or the means of operating them, readily accessible?

Check the accessibility of all isolation valves, or the means of operating them.

Appliance isolation valves, or the means of operating the valves, must be readily accessible.

Note – Isolation valves located behind free-standing LPG cookers that are restrained from tilting, are compliant if the restraint can be unfastened without the use of tools.

Best practice

We recommend using the main shut-off valve as the primary emergency shut-off.

b**Best practice**

We recommend all appliances are protected by an appliance isolation valve.

We recommend the industry best practice that valves which are not immediately adjacent to appliances, or otherwise in open view, have their location, and the identity of which appliance they serve, clearly marked.

For ease of use and maintenance we recommend having these valves readily accessible, the operating instructions marked on or close by. If the valves operate by rotation, it is industry best practice that they close by turning clockwise.

b

7.12 Testing for LPG system tightness

It cannot be assumed that a boat's LPG system is leak-free without checking. This section covers the requirement for a means to test and the available options for testing. (see illustrations on Pg 38).

7.12.1/R REQUIREMENT

Is there a LPG test point in the system, or a bubble tester in the cylinder locker or housing?

Check for the presence and location and accessibility of a means to determine the LPG system tightness.

All LPG systems must be fitted with one of the following means to determine gas tightness:

- a readily accessible proprietary test point on an appliance; or,
- a readily accessible proprietary test point fitted in the pipework; or,
- a bubble tester installed in a cylinder locker or cylinder housing.

7.12.2/R REQUIREMENT

Is the LPG system free of leaks as defined in the tightness test?

The regular verification that the LPG system is leak-free is important. The use of suitable proprietary bubble testers is strongly recommended, as it allow boaters to easily, routinely and safely test for gas leaks.

Alternatively have a competent person use the built-in test point(s) as detailed in Appendix C of the Examination Checking Procedures, which is available on www.boatsafetyscheme.com or by post or email from the BSS Office.

Vessels used for certain purposes, e.g. as a main residence, may be governed by UK law, thus restricting this latter method to CORGI-registered fitters.

All LPG systems must be free of leaks when tested in accordance with the appropriate tightness test procedure.

Notes – If for any reason the tightness test can not be completed when required, the soundness of the system is ‘not verified’ and it is considered as non-compliant until it can be verified. The reason for non-completion must be recorded.

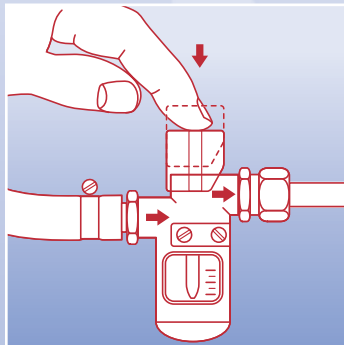
A leak in the system is classified as ‘immediately dangerous’. A Warning Notice will be issued and the navigation or harbour authority will be informed.

Information

There is more information on the tests that check the tightness of a gas system in PD 5482-3.



Bubble tester - a highly recommended installation



Follow manufacturer's operating instructions.